A CONTRIBUTION TO SPINAL-CORD SURGERY.

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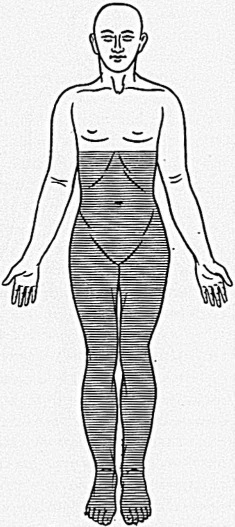
The subject of surgery of the spinal cord has recently received so much attention and discussion, finding urgent advocates in some and opponents in other directions, that every case bearing on the question is of value, particularly as much of the argument, until very recently, has been based mainly on theoretical grounds and misconceptions. The number of thoroughly reported cases is yet small, and ultimate results often unknown, making deductions difficult and uncertain. The mortality rate is, of necessity, very high with operation, and without it a fatal termination, in any considerable injury to this important structure, is the almost invariable rule. Occasionally, however, surgical interference has saved a life that would otherwise have undoubtedly been lost, and post-mortem findings not rarely lead to the conclusion that properly directed operation might have gained further victories.

Regarding the history, technique, and bibliography of the subject, it is not our purpose to speak, except as variations or peculiarities in our cases call for comment. The whole matter has been recently so well set forth by Prof. J. William White, of Philadelphia; and by Thorburn, Horsley, Abbe, Lloyd, and others, to whose works we gladly refer for these details, and to whom we have personal acknowledgments to make, that a repetition would be superfluous. These cases are of value from the physiological standpoint also, for in some instances they correspond by the exactness of conditions to experimental investigations upon lower animals, with the added advantage of being free from the obvious drawbacks of such experiments and their probable lack of parallelism with what occurs in man.

Investigations as to motion, sensation, reflexes, and other similar points were carried out as fully as the condition of the patients would warrant, and were in every instance frequently repeated and verified by a number of observers. In order to be as brief as is consistent with clearness, negative conditions are omitted, as a rule, from our reports, each of which, it is hoped, may convey its own lesson. We desire to express our obligation to the various surgeons in immediate control of the patients, for their courtesy and the privilege of publishing their operations.

CASE I. *Gunshot injury to the spinal cord at level of third dorsal segment; paralysis of limbs and trunk; lamnectomy; death twenty-one days after operation.*—I. K., aged twenty-eight years, received one bullet-wound from a revolver of large calibre, fired at a distance of five feet to the left and somewhat in front of the patient. He remembered falling to the ground, but nothing further until brought to the hospital, where examination showed a wound in the fourth left intercostal space in the mid-axillary line. There was pneumothorax, but no evidence of hemorrhage into the pleural cavity. The case was treated as one of gunshot wound of the chest until the patient was asked to turn upon his side, when it was found that both lower limbs and the muscles of the lower half of the trunk, with the exception of the abdominals, were completely paralyzed. Respiration was abdominal and not labored. There was no paralysis of any of the muscles of the upper extremities. As shown in the figure (Fig. 1), there was complete anæsthesia of the trunk and both lower extremities, the highest level of this area being at the lower border of the seventh rib. No hyperæsthesia above this level could ever be detected while in the hospital. Upon admission he had no subjective sensation except that of numbness in both arms. All the superficial and deep reflexes were lost below the level of the lesion. Marked priapism, but no seminal emissions. There was retention of both urine and feces for three days, and no sensation on passing the catheter. The pulse was 96; temperature normal. Sixteen hours after admission an exploratory lamnectomy was performed by Dr. Weller Van Hook, in order to ascertain whether the pressure symptoms were due to hemorrhage or to a fracture. After the usual preparations and the use of chloroform as an anæsthetic, the patient was placed in a semi-prone position. An incision was made five inches long, its centre opposite the third dorsal spine. The spinous process and laminæ of this vertebra were removed and the cord and its membrane, apparently in a normal condition, exposed. The posterior arch of the second dorsal vertebra was then removed by means of a chisel and rongeur forceps. The spinal canal being thus opened, the cord was found reduced to an unrecognizable pulpified mass for a distance of one and a half inches. Suturing of the severed ends being impossible, the wound was irrigated with warm (110°) sterilized water, the dura sutured with fine catgut, deep muscular and superficial cuta-

FIG. 1.



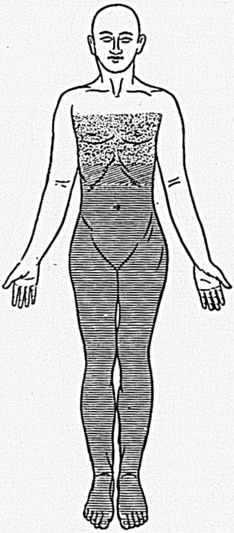
Case I. Showing area of anæsthesia in lines.

neous sutures of silk being inserted, with the use of iodoform gauze at the upper and lower angles of the wound as a drain. The patient was in excellent condition after the operation, although respiration was suspended once. His symptoms changed but little during the remainder of his stay in the hospital. After the operation he was placed upon a water-bed. There was marked tympanites at intervals, and alternately retention and involuntary evacuation of both feces and urine. His temperature varied between 99° and 102°. Seventeen days after the operation the patient requested his discharge. He died at home four days after.

A post-mortem examination was held by the coroner's physician, Dr. Ludvig Hektoen, who found the bullet imbedded in the substance of the cord opposite the second dorsal vertebra. There was much subdural hemorrhage at this point, and acute cystitis and pyelo-nephritis.

CASE II. *Gunshot injury to the spinal cord at level of fifth dorsal vertebra; paralysis of lower limbs and trunk; lamnectomy; death thirty-one days after operation.*—W. D., aged nineteen years, was admitted to the service of Dr. T. J. Conley on September 2, 1891. He had received, about one hour before, two bullet-wounds from a revolver, held about six feet behind and somewhat to the left. One bullet entered the outer aspect of the left arm and was found subcutaneously on the inner aspect. The other entered about one-half inch to the left of the spinous process of the fifth dorsal vertebra. He was "immedately" paralyzed in both lower limbs, according to his own statement, and upon being turned over the escape of a clear, watery cerebro-spinal fluid was noticed by a bystander. On admission he was found to be well nourished, rational, and complained of a "dead rumbling" in both legs. Respiration abdominal, with no evidence of dyspnœa. The above wounds and the escape of the fluid were noted. There was paralysis of both lower extremities and of the lower half of the trunk. Complete anæsthesia with its highest level extended transversely around the body about two inches above the umbilicus. Between this level and the ninth rib there was incomplete anæsthesia, and from the upper boundary of this area to the second rib a transverse zone of hyperæthesia existed. This is most marked in the parasternal and mid-axillary lines (Fig. 2). There was complete retention of urine and

FIG. 2.



Case II. Showing area of anæsthesia by transverse lines, of incomplete anæsthesia by diagonal lines, and of hyperæthesia by dots.

feces, accompanied by incomplete priapism, but no emissions. The deep reflexes were all absent. The cutaneous, viz., plantar, cremasteric, gluteal, and abdominal, were all faint on the left side, absent on the right. This is easily explained by the fact that, as was ascertained during the operation, the cord had not been completely destroyed on the left side. The pupils were dilated and mobile; the pulse was 90, full and soft; temperature normal; there was no evidence of shock or of hemorrhage.

In the hope of relieving any bony compression, and at his own request that some effort should be made, the patient was anæsthetized, chloroform being employed, and then placed in an almost full prone position, his thorax resting upon a pillow. An incision five inches long was made along the median line of the back with the bullet-wound as its centre, and carried down to the bones. The bullet was found to have passed beneath and splintered the left lamina of the fifth dorsal vertebra, penetrating the spinal canal at this point. The left lamina and spinous process were removed with a chisel and bone-forceps and the dura incised. There was no subdural hemorrhage, but fragments of bone and of clothing were removed. The spinal cord was found to be almost completely severed, a few fibres only of the left lateral columns remaining. Upon exploration of the wound the bullet (38-calibre) was found imbedded in the body of this vertebra a little to the right of the median line, and removed. The wound was irrigated with warm sterilized water, the dura sutured with fine catgut; deep muscular and superficial cutaneous silk sutures, with an iodoform gauze drain, were inserted. The patient left the table in excellent condition and was placed upon a water-bed.

There was but little change in his symptoms during the twenty-seven days in which he remained under observation. Considerable tympanites existed at intervals. Retention of urine, with the escape of a clear, glairy mucus from the meatus, and of feces, persisted throughout. The temperature ranged between 98° and 103°. There was no union of the wound, owing to the constant escape of cerebro-spinal fluid. No bedsores developed during his stay in the hospital. Upon September 29th, twenty-seven days after the operation, he requested his discharge, and, as we learned subsequently, died at his home four days after leaving the hospital. He was perfectly rational up to the moment of death, and no change had occurred in his symptoms. A post-mortem examination made by Dr. Hektoen showed a fibrino-plastic meningitis above and below the seat of injury; a destruction of cord substance, with the exception of a few of the fibres of the left lateral columns for a distance of one and one-half inches at the fifth dorsal vertebra, acute cystitis and pyelo-nephritis.

The question may be asked why were either of these cases of gunshot wound operated upon when all symptoms indicated a complete destruction of the cord? In reply to this, as eminent an authority as Gowers may be quoted. He states that in such cases the cord suffers more often from displaced fragments of bone than from the ball itself. A bullet may strike the spinal column and cause immediate paraplegia as complete as if the cord had been divided, and yet it may be found that the cord itself is not at all injured; all this resulting from mere concussion. Hence it seems perfectly justifiable to explore the wound thoroughly by means of an aseptic lamnectomy, which, as is shown in both cases, did not shorten the duration of life, but probably by the relief of inflammatory or other pressure actually prolonged it. The second case is especially interesting,

1st. Because the escape of cerebro-spinal fluid afforded positive evidence of entrance into the spinal canal.

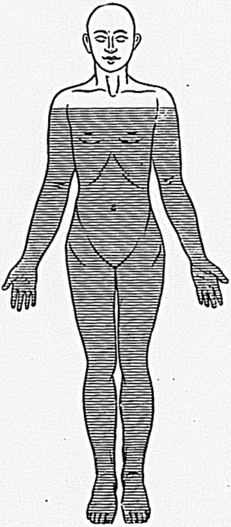
2d. Because of the only partial loss of reflexes upon the left side, the cord not having been severed completely on this side at the seat of injury.

3d. That operation under antiseptic precautions is perfectly justifiable as giving the surgeon the opportunity of excluding bony compression, and is not merely a meddlesome interference to remove a probably septic bullet.

4th. That suture of the spinal cord is still impossible.

CASE III. *Fracture of fifth and sixth cervical vertebræ; complete paralysis of limbs and trunk; lamnectomy twenty hours after injury; death eight hours after operation.*—C. H., aged twenty-nine, was admitted June 25, 1891, deeply intoxicated, in a semi-comatose condition, pupils dilated, breath smelling strongly of alcohol. He was asked to sit up, but on account of the intoxicated condition his non-compliance was unobserved. He was sent to a ward to "sober up." He had been found by the police lying on the sidewalk, and was unable to answer any questions or to respond to any form of stimulation or even severe supraorbital pressure. A few hours after, when he became more rational, an examination revealed a complete paralysis of both upper and lower limbs and of thoracic and abdominal muscles. Respiration was jerky, diaphragmatic, anæsthesia extended as high as the upper border of the third rib in front, and the fifth dorsal spine behind. Its highest level on the arms was a projection of the line of the upper border of the third rib. (Fig. 3.) It was impossible to ascertain whether any hyperæsthetic area existed. Pupils were widely dilated. There was no evidence of the involvement of any of the cranial nerves. There was complete absence of both superficial and deep reflexes. There was turgidity of

FIG. 3.

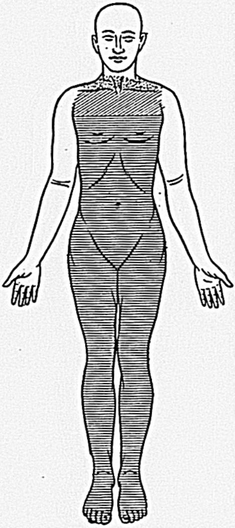


Case III. Anæsthesia shown in lines.

the penis, but no erection or emission; retention of urine, but involuntary defecation. He was now able to state that he had fallen a distance of eight feet, striking upon his head. There was tenderness on pressure over the cervical region, with a depression opposite the spines of the fifth and sixth vertebræ. The temperature rose from 97.8° on admission to 104°, axilla, seventeen hours after the injury. The patient's condition being clearly hopeless otherwise, an exploratory lamnectomy was performed by Dr. Albert I. Bouffleur at 8 P. M., twenty hours after injury.

The head and back of the neck having been shaved and carefully prepared, an incision was made over the cervical spinous processes, having its centre opposite the fifth. The muscles and ligaments having been cleared from the arch, the spinous processes of the fifth and sixth were found freely movable and crepitating, the right laminæ of these vertebræ were removed with a chisel and rongeur forceps, thus exposing the spinal canal, from which considerable clotted and fluid extra-dural blood escaped. The dura presented a perfectly normal appearance. As nothing further could be done, the muscles were brought together by deep coarse silk sutures, and a large drainage-tube and superficial fine silk sutures inserted, and the patient placed upon a posterior splint padded in the cervical region. The pulse upon leaving the table was 120, small and soft; respiration very shallow and labored. The temperature rose to 106° axilla. He gradually became more cyanotic, and eight hours after the operation died apparently of respiratory failure. No post-mortem examination could be obtained.

FIG. 4.



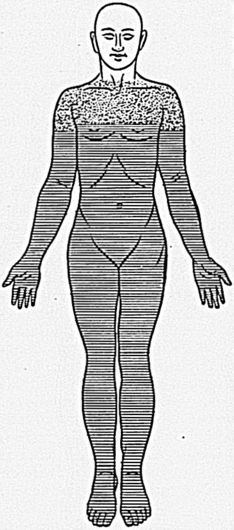
Case IV. Showing complete anæsthesia in transverse lines, of partial anæsthesia in diagonal lines, and of hyperæsthesia in dots.

Whether in this case there was a fracture of the bodies of the fifth and sixth cervical vertebræ, or a dislocation existed which had been reduced by manipulation resulting in a temporary crush of the cord, it is impossible to state.

CASE IV. *Dislocation of second dorsal and first lumbar vertebræ; fracture of the twelfth dorsal vertebra; paralysis of lower limbs and trunk; lamnectomy sixty-two hours after injury; death fifteen hours after operation.*—G. T. was struck in the breast by a cable grip-car, and fell backward, being found in an unconscious condition. He was admitted to the service of Dr. Jacob Frank about one hour after injury, and, in addition to the simple fracture of the sternum, there was a soft, fluctuating swelling corresponding to the normal position of the spine of the first lumbar vertebra, into which the finger could be pressed very deeply, indicating an absence of the spinous process. A deformity existed in the upper dorsal region caused by the projection backward of the spine of the second dorsal vertebra; crepitus and a false point of motion upon manipulation of the arch of the twelfth dorsal vertebra. Pulse was 90, full and soft, but soon became rapid and almost imperceptible. Respiration 24, diaphragmatic and shallow. The lower limb, abdominal and intercostal muscles were completely paralyzed, and anæsthesia extended as high as the upper border of the third rib. (Fig. 4.) From this highest level of anæsthesia to the clavicle there was incomplete anæsthesia, and extending an indefinite distance above this an area of hyperæsthesia. Reflexes, both superficial and deep, absent except the left cremasteric, which could easily be elicited upon stroking the left thigh. There was complete priapism and retention of the urine and feces. Sixty-two hours after injury an exploratory lamnectomy, with the hope of reducing the dislocations, was performed by Dr. A. E. Halstead. An incision was made over the first lumbar vertebra, and the swelling noted upon admission was found to be due to a large hæmatoma dissecting up all the muscles. The left lamina and spinous process of the twelfth dorsal vertebra were found fractured, and were removed. After the hæmatoma had been washed out with warm sterilized water a dislocation directly forward of the first lumbar vertebra, with a flexion of the cord, was noted. Extension was made on the lower limbs, followed by flexion of thighs on pelvis, and pelvis on trunk, and thus luxation fully reduced, and an attempt made to maintain it by fixation in this position with pillows and bandages. While this wound was being sutured an incision was made over the prominence in the upper dorsal region, and by fixation of thorax and extension of neck on trunk this dislocation was also reduced, but relapsed easily into the former position. Owing to the very low condition of the patient, it was deemed inadvisable to attempt to maintain permanent reduction by means of silver wires. The patient's condition became worse, respiration became more labored and rapid, temperature rose to 106° axilla, and death occurred fifteen hours after operation, the patient never having rallied from the shock. No post-mortem examination was held.

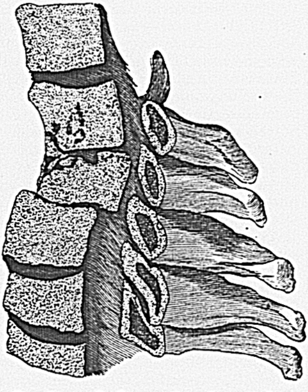
CASE V. *Fracture of body and laminæ of fifth cervical vertebra; complete paralysis of limbs and trunk; death eight days after injury.*—J. A., aged thirty-five, was admitted to the service of Dr. Sanger Brown, November 8th. Brought by police ambulance, with a history of having been arrested on the previous evening while intoxicated and placed in a cell. Upon the morning of admission he was found lying upon the floor of the cell, and when asked to get up stated that he was unable to do so on account of the paralysis of both legs. The manner in which the accident occurred was not to be ascertained either from the patient or the police. Examination revealed severe pain referred to back of neck when the head was moved, and he said he felt better when the head was extended. A marked depression existed opposite the spine of the fourth cervical vertebra, and upon manipulation crepitus could be obtained. No irregularities could be felt on the pharyngeal side through the mouth. There was considerable tenderness when pressure was made over the cervical region. Respiration was shallow and diaphragmatic; pulse 64, small and soft; temperature subnormal; pupils contracted and feebly mobile. There was complete paralysis of the lower limbs and of the abdominal and thoracic muscles. The position of the upper limbs was not noted at this time, but all the muscles, with the exception of the biceps, supinator longus, and deltoid, were paralyzed, so that when he was asked to move his arms he would flex the elbows, abduct the humerus, and supinate the hand in the order named. There was incomplete anæsthesia at the time of admission, the patient being able to localize tactile sensation on his lower limbs and abdomen fairly well. Only the patellar reflex was observed, and this was found absent. Marked priapism without seminal emissions; retention of urine, and later involuntary evacuation of feces. Examination a few hours later showed complete anæsthesia of lower limbs and trunk up to fourth rib anteriorly, and to level of second dorsal spine behind, and on arms to conjunction of upper and middle thirds of arm in front, and to a little above elbow on the outer and posterior aspects. Above the upper level of the area of anæsthesia on both arm and trunk there was hyperæsthesia extending about two inches above the clavicle. (Fig. 5.) All the deep and superficial reflexes were absent, with the exception of the plantar, which was faint, and the cremasteric, almost imperceptible. There was complete paral-

FIG. 5.



Case V. Anæsthesia shown in lines, hyperæsthesia in dots.

FIG. 6.



Drawing made from post-mortem specimen (Case V.), showing fracture of body of fifth cervical vertebra, and its projection into the spinal canal.

ysis of both upper and lower extremities, the patient being able to use the posterior scapular muscles only. His arms were semiflexed, adducted, and pronated. Priapism had disappeared. Temperature had risen to 106.2° F., axilla.

November 11th, three days after the injury, the condition remained unchanged. There was complete retention of the urine and involuntary defecation. His temperature had fallen to 99°, axilla. He was placed upon a water-bed, the head of which was raised at an angle of 45°, and the portion used to support the head in the Sayre's suspension apparatus applied so that there would be a tension upon the fractured vertebra. During the manipulation in applying the extension the patient suddenly became cyanotic, and respiration ceased, but was restored upon extension of the head on the neck. No improvement followed the use of the extension. The patient gradually sank, and died November 16th, eight days after the injury. A post-mortem examination made by Dr. Ludvig Hektoen showed a fracture almost symmetrical of the laminæ, near the body of the fourth cervical vertebra. No subdural hemorrhage. As shown in the drawing (Fig. 6), there is a comminuted fracture of the upper half of the body of the fourth vertebra, causing a marked projection into and narrowing the lumen of the spinal canal, and producing an area of softening in the cord itself directly opposite the point of fracture. Sections showed the cord to be red, markings obliterated and very soft.

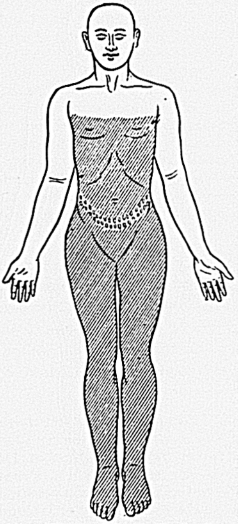
The post-mortem findings in this case lead to the conclusion that an early operation would have given the patient the best opportunity for recovery. The injury to the cord was at the level of the sixth cervical segment, and verifies, by the paralysis at first of all the muscles of the upper extremities excepting the biceps, supinator longus, and deltoid, the localization of the spinal centres for this segment, as laid down by Thorburn and others.

CASE VI. *Sarcoma in substance of cord at level of fourth and fifth dorsal vertebræ; operation, enucleation; death on fifth day.*—The following absolutely unique case we are permitted to report by the kindness of Dr. Christian Fenger, of this city. The notes are mainly by Dr. Frank Billings, who saw the case in consultation and at the time of operation.

The history of the patient in brief is this: He was a native of Ireland, thirty-eight years of age, and lived in this State (Illinois). He had been treated at Freeport. His personal history was clouded by ignorance; he knew very little about his people and gave a remarkably obtuse history concerning himself. He seemed, however, to be free from hereditary taint of any kind. He was unable to give any exact dates concerning his present sickness; he stated that about one year ago he was seized one night with a severe pain in the lumbar region of the spine, so severe that a physician was called. This pain repeated itself for three nights; it disappeared, or at least diminished, during the day, so that he attended to his business, that of a saloon keeper. He said the pain did not disappear after that, but continued, although not so severe as during the first three days, until he came to Chicago. He described the pain as of a dull aching character, and situated directly in the spinal column about the lumbar vertebræ. No other symptoms developed for three months; then he began to feel weak in his right lower extremity, and simultaneously with the development of that weakness he felt a constricting band about his abdomen midway between the umbilicus and pubes. About three months after the development of weakness in the right lower extremity the left lower extremity became affected and he became unable to walk. That was some time in January 1890. His bowels were not affected, although he suffered from constipation after taking to his bed; he was always able to void his urine voluntarily. He was brought to Chicago and placed in the Emergency Hospital in Dr. Fenger's care.

He was robust in appearance and well nourished; complained of the constricting band about the abdomen between the umbilicus and the pubes, and occasional lancinating pains extending down the lower extremities along the nerves in front and behind. He complained of the constipation that I have mentioned, and said he had been always able to void his water, but on examination I found the bladder distended to the umbilicus and drew off a full complement of urine. Examination of the man showed nothing abnormal above the diaphragm as far as the internal organs were concerned. His lungs and heart seemed to be in normal condition, and he had good strength in his arms and the muscles of his head and neck. Below the fourth rib (Fig. 7) there was almost entire absence of temperature sense, and greatly diminished tactile sensation; he could tell when anyone touched his skin, but that was all. There was paresis of the lower extremities, more of the left than of the right limb, but with marked increase of all the reflexes of the lower extremities; all superficial and deep reflexes were present everywhere. These were all the symptoms the man presented in addition to the band of constriction about his body midway between the umbilicus and pubes.

FIG. 7.



Case VI. Partial anæsthesia shown in diagonal lines, and girdle sensation in dots.

We arrived at a diagnosis of pressure myelitis from the fact of its developing so slowly, and from the fact that there were present an increase of all the reflexes in the body. Horsley and Gowers have laid down the rule that the tumor that presses on the cord is two inches above the pain, which, as you remember, in this case was on a level with the constricting band, midway between the umbilicus and the pubes, but, as there was anæsthesia as high as the fourth dorsal vertebra, which was hard to explain, it was decided that if an operation was performed it should be at that point. The man consented to the operation, and on the 5th of June Dr. Fenger cut down upon the fourth dorsal spine, making an incision which laid bare the spinous processes of the third, fourth, and fifth dorsal vertebræ, and after cutting away the spines of those three and the laminæ of the fourth and fifth, no tumor could be found pressing upon the cord. Externally the membranes of the cord and the fat surrounding it looked normal—looked as if we had missed the diagnosis.

Having made an incision through the dura mater, the cord upon inspection looked normal, but upon passing the fingers over it there was a distinct enlargement of its posterior half, and a longitudinal incision along its posterior median line revealed a tumor nearly two inches long, conical at both extremities, largest in the middle. It was incised in the centre to remove it, and one-half used for microscopic examination by Dr. George S. Isham. It has been found to be a large spindle-celled sarcoma. The tumor was easily enucleated and seemingly without hemorrhage, and then the dura mater was almost closed, leaving slight capillary drainage, and the wound closed in an antiseptic manner. The man had complete paraplegia after the operation. For two days his temperature did not exceed 101°, ran from 99° to 101°, then rapidly developed to 103½°, and he died of septicæmia on the fifth day after the operation.

That portion of the cord involved in the operation was removed post-mortem, and was placed in Müller's fluid. The anterior two-thirds of the cord was intact, the gray matter seemingly was not compressed, the tumor lay in the posterior third of the cord and was covered with a thin layer of the white columns. The cause of the paraplegia that followed the operation was a hemorrhage in the cord just below the tumor, that was probably a post-operative hemorrhage, extending almost transversely through the cord. Before the cord was incised longitudinally to get at the tumor a softened spot could be felt just below the latter, and at that spot the hemorrhage occurred.

But for the septicæmia that developed it is possible that this man would have recovered, at least to a great extent, his power of motion; perhaps he would have had some anæsthesia from the laceration of the posterior part of the cord, but it seems possible that this operation might have relieved him. There was a purulent infiltration of the soft tissues all about the wound, and localized suppurative spinal meningitis. Why this occurred no one can say, as every care as to cleanliness was taken during the operation.

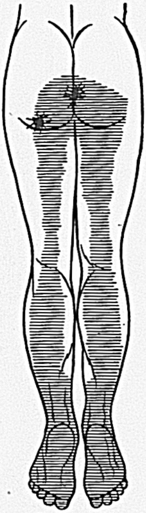
The girdle pain at the level of the last dorsal segment is not readily understood by the findings in this case, and as this portion of the cord was not investigated post-mortem, it must remain unexplained.

CASE VII. *Crushing injury of the cauda; operation after two years; some relief.*—We are under obligation to Dr. J. Frank, surgeon to the St. Elizabeth Hospital of this city, for the privilege of reporting this case, which has been carefully watched for two years by one of us.

J. M., a Polish boy aged nineteen years, of good habits, presenting a personal and family history free from notable peculiarities, a carpenter by trade; on the 18th of July, 1888, fell from a roof upon which he was working, to the ground, a distance of thirty-six feet. Ten feet from the ground he came in contact with another building, striking his back, finally alighting upon his feet and then falling unconscious, and so remained until carried a short distance into the street. From the very first there was complete loss of power in the lower extremities and much pain throughout the entire length of the back. The feet were numb and without sensation, but a darting pain in the legs persisted for weeks, gradually passing away. There was also more or less anæsthesia as high as the groins. Over the sacrum was an extensive ecchymosis which rapidly went on to the formation of a large slough within the first three days. The extremities rapidly swelled greatly, and this lasted for a week. After three days, no water having been passed, he was catheterized by the physician in charge of the case, and it was noted that the penis and scrotum were absolutely anæsthetic. When the bowels moved upon the exhibition of a cathartic the patient could not feel anything passing from the anus. Catheterization was required for a fortnight, when incontinence followed, the urine constantly dribbling away in both the recumbent and erect positions, and it is only during the past year that he has been able to retain his water for about three hours at a time. The bowels moved often without his knowledge, so that he unconsciously soiled his bed or trousers. Afterward by going to stool at regular intervals he managed to keep himself clean, but never experienced any sensation from the passing feces. The paralysis in the limbs, which seems never to have been complete, gradually improved. He sat up after the first month, but was confined to a chair when not lying down, for six months. Then he commenced to get about by pushing a chair before him. During the past four or five months he has been able to walk about his room and for short distances in a feeble and uncertain manner. Since the accident there has never been an erection of the penis or a seminal emission. Other organic functions have been properly performed, and his physical health has never been seriously undermined or even temporarily notably affected. Previous to his admission to the St. Elizabeth Hospital, under the care of Dr. Frank, he has been in the hands of numerous physicians, and spent some months in the Alexian Brothers' Hospital in this city. The slough over the sacrum never properly healed, and a fistulous tract formed leading to the sacro-coccygeal joint, with a dense cicatrical and extensive opening in the middle line. About five months ago a second similar opening formed in the lower and inner aspect of the left gluteal region. These have been painless, and the patient has also noticed that he could not feel the floor with his feet or the chair upon which he was sitting, and that the back of his thighs and legs were insensible to wind blowing upon them, or to pinching, or any form of sensory impression.

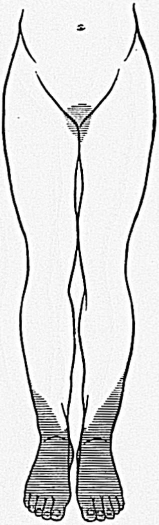
March 20, 1890, he presents the following condition: His attitude is uncertain, and he can only stand with his feet well separated. When he walks the pelvis oscillates, and the femora wabble around in their sockets as the weight of the body falls upon them. There is weakness in all the movements of the lower extremities, but particularly in the rotation of the thighs. Over an area embracing exactly and only the cutaneous distribution of the four lower sacral nerves, in the territory supplied by the pudic, small sciatic, external saphenous, musculo-cutaneous, anterior tibial, and posterior tibial nerves, there is complete anæsthesia for tactile, pressure, thermic, electric, and painful impressions, all of which are, as nearly as can be determined by repeated tests, coextensively abolished. This area is shown in the darkened outline made from a photograph of the patient after the anæsthetic region had been marked out with nitrate of silver. (Figs. 8 and 9.) The cutaneous extent supplied by the lumbo-sacral cord and first sacral nerve are absolutely free from sensory disturbance.

FIG. 8.



Case VII. Showing area of anæsthesia and fistulous openings.

FIG. 9.



Case VII. Showing anæsthesia.

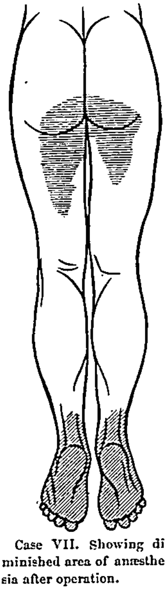
All the muscles of the lower extremities react to both electric currents, with no changes in the order of response to the galvanic stimulus, but the muscles of the feet, including the calf muscles, respond feebly. Unfortunately, the rotators of the femur, which are supplied by branches from those sacral nerves which show implication in their cutaneous distribution, are so deeply situated that they cannot be electrically examined, but their paresis is shown in the characteristic gait and the weakness of inversion and eversion of the foot.

The lower portions of the glutei maximi seem wasted, and the trochanters are, perhaps, unduly uncovered and prominent.

The knee-jerk is almost abolished, while the plantar and gluteal reflexes are entirely absent. The cremasteric is active, and reflexes above this level are present.

The anus is patulous. The introduced finger encounters no sphincteric resistance whatever, and the patient cannot feel it in the slightest degree, even when deeply and forcibly inserted. The rectum is empty, as is the bladder. The prostate and seminal vesicles can be readily made out. There is great mobility of the coccyx, and grating at its articulation with the sacrum, but the latter bone does not present any abnormality to the investigating finger on its concavity, even as high as the promontory.

FIG. 10.



Case VII. Showing diminished area of anæsthesia after operation.

A diagnosis of injury to roots of lower four sacral nerves was made by Dr. Church, in which Dr. Sanger Brown, who kindly saw the patient, concurred, and an exploratory operation was advised in the hope that some pressure might be relieved, or, possibly, nerve suture be employed, and, at the same time, to close the ulcerating openings and rectify the diseased condition of the sacro-coccygeal joint.

September 26, 1890, under ether, by a median incision the spines of the sacrum were uncovered by Dr. Frank, and the fistulous opening over the coccyx included. This bone, or a small carious portion of it, was dissected out. The sacrum seemed strangely distorted, presenting about its middle a loss posteriorly, and when this was invaded with chisel and mallet no neural canal could be found. It was as if the bone had been crushed, impacted, and hypertrophied. At the lower level of the first sacral vertebra the spinal canal was found and the crushed-off termination of the dural sheath and cauda equina. The nerve roots of the cauda extending below this level were completely destroyed, or, at least, no trace of them could be found. Hemorrhage from the bone and soft parts was everywhere profuse, requiring much time for its control, and the portion of the bone removed showed inflammatory changes and infiltration. A fragment of the sacrum, probably including its two lowest segments, was found loose and came away, giving high access to the posterior wall of the rectum. The fistulous opening in the left buttock was also widely opened, and a saccular lining full of cheesy material dissected out. The cicatricial margins of both openings were trimmed away, and the parts closed with deep sutures.

October 19*th*. There is great improvement in sensation. About the toes it is blunted to some extent, but not absolutely; everywhere else it is normally acute, excepting in the gluteal region and the upper back portion of the thighs, the perineum, scrotum, and under portion of penis. (See Fig. 10.) The penile meatus and anterior urethra are comparatively insensitive, but the anus responds to pricking, has some muscular sphincteric control, and motions are felt when he goes to stool. Movements in the right lower extremity are well performed, but below the knee on the left side there is complete motor paralysis, probably due to the breaking of a nerve-cord at the time of operation. Since the operation there has been much loss of weight, and the same atrophy in the gluteal region and throughout the lower extremities is present. The wound over the sacrum healed completely by first intention. The one over the left ischial tuberosity gapes widely, but is granulating freely, and seems disposed to heal. The peculiar saccular condition before noted is still present.

November 9th. Anæsthesia practically the same. Left leg and foot paralyzed for all motions, excepting the slightest lateral motion of foot at ankle-joint. Has had several erections. No ejaculations. More security in the hip-joints; gaining physically. Opening over left tuber ischii shows no tendency to close. Is receiving some electrical treatment of indifferent sort.

Four months after operation he left the hospital, with no improvement in gait, and power in left limb less than upon admission, but sensation much improved by the notable lessening of the anæsthetic area, and by the restored sensation and control of rectum and anus.

It is difficult to understand why there should have been a gain in sensation following the operation for the complete division of the cauda; and disappearance of all nerve structures below the first sacral vertebra did not permit us to hope for any repair or restoration of function.

CASE VIII. *Fracture of tenth and eleventh dorsal vertebræ, with dislocations between them; compression of cord; extra-dural hemorrhage; operation; excellent recovery.*—J. K., aged thirty-one years, teamster, German, about 10 A.M., on the 11th of March, 1891, was riding on a load of bricks, and while driving under a low shed was struck just below the nape of the neck while his body was in an extremely stooped position. As the wagon proceeded the ends of his vertebral column were brought nearer to each other than the anatomical continuity would permit, and, consequently, he sustained a fracture and dislocation of the vertebræ. He felt "something break," and after the wagon had cleared the shed he was found lying flat on his back on top of the load. He tried to get up, but found that he could not elevate his trunk or move his legs at all. In answer to his cries, friends came to his assistance, and lifted him from the wagon and tried to stand him up, but his legs would not support him; then they tried to sit him up in a chair; but the slightest relaxation of their support caused him "terrible pain," as he put it. He was admitted to the Cook County Hospital the same day, in the service of Dr. A. I. Bouffleur, who permits us to report the case.

Examination. An immense swelling over the whole dorsal region was noted, also a marked deformity of the back. It was found that there was a marked prominence about the eleventh vertebra, and an equally marked depression just above it. The immense diffuse swelling was soft and semi-fluctuating, being caused by extensive extravasation of blood

In all cases where it is definitely stated that the motions were colorless from the first (with one exception) there was no bile found in the gall-bladder.

In 10 cases examined microscopically, cirrhosis of the liver was present in 9.

The author quotes several cases of infantile jaundice with symptoms similar to those of obliteration of the bile-ducts, but with pervious ducts. The resemblance is such that he cannot avoid the conclusion that they are examples of different stages of the same disease. The striking point is the shorter duration of the cases with pervious ducts.

The lesion of the ducts has been ascribed to: 1. Peritonitis and its results, acting from without. 2. An inflammatory or other lesion of the ducts themselves. 3. An arrest or defect of development.

The author regards the last of these as being the most probable etiology. A congenital narrowness or irregularity of the lumen of the ducts of such a nature as to render them unnaturally liable to disease from interference with the proper performance of their function, appears to him to "afford a very necessary help in explaining the causation of a large proportion, if not of all the cases."

Congenital syphilis is not considered to be of essential importance as an etiological factor.

The author summarizes his conclusions as follows:

1. In the great majority (if not all) of the cases there is, to begin with, a congenital malformation of the bile-ducts due to defective development.

2. This malformation probably affects a considerable extent of the walls of the ducts, and may consist in narrowness of their lumen.

3. The interference with the outflow of bile thus caused gives rise to catarrh, and, finally, to blocking and obliteration of the ducts, owing to the inflammatory process spreading to the walls of the ducts and gall-bladder.

4. This progressive inflammation goes on slowly spreading, the local condition getting gradually worse during many months, if the patient lives.

5. The obliterated ducts or gall-bladder, or portions of them, may entirely disappear, not even leaving a distinct band of fibrous tissue to indicate their original position.

6. The obliteration generally becomes complete at an early but variable period of intra-uterine life, but occasionally it does not occur till after birth.

7. In a few cases the inflammatory process spreads to the peritoneum, and possibly the presence of inherited syphilis may favor this extension. The occurrence of peritonitis is probably always secondary to the blocking of the ducts; and syphilis has nothing to do with the original lesion in them.

8. When the lumen of the duct is so far encroached upon as to obstruct the free passage of bile into the intestine, "biliary" cirrhosis of the liver begins, which, as it goes on, causes increasing interference with the most important functions of that important organ. The result of this is the setting up of a sort of chronic blood-poisoning, which causes vomiting, spontaneous hemorrhage, and convulsions, and gradually leads to emaciation, diminished vitality, and death.